AD-A182 467 STUDIES OF WATER METAL IONS PROTEIN DYNAMICS AND ION CHANNELS(U) RICE UNIV HOUSTON TX H W HUANG 12 JUN 87 N00014-76-C-0273 1/1

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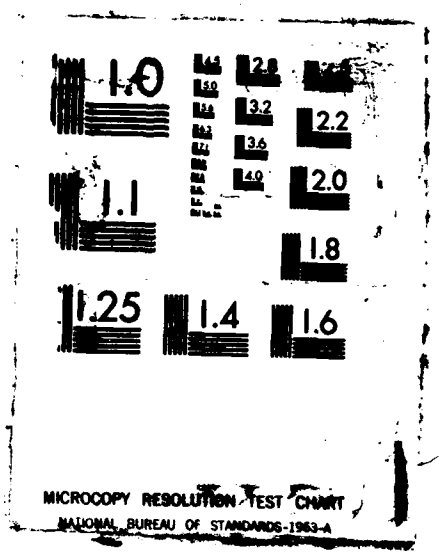
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June 12, 1987

Final Technical Report on the Office of Naval Research Contract N00014-76-C-0273

Period: September 30, 1975-May 30, 1986

Principal Investigator: Huey W. Huang

Contractor: Rice University

Contract Title: Studies of Water Metal Ions, Protein Dynamics, and Ion Channels

SUMMARY OF ALL WORK ACCOMPLISHED:

1. The theory and phenomenology of cellular sodium/potassium ion distribution and thermodynamics of allosteric transitions. The phenomenology of cellular Na^+/K^+ ion distribution was described by a simple Ising model which represents the mechanism of allosteric transitions in proteins. The dynamic behavior of this Ising model was solved rigorously by statistical mechanism and was found to agree with the experimental measurements of Na^+/K^+ exchange in lymphocyte cells - Reports 1-6.

2. Use of synchrotron radiation to study the chemicophysical states of metal ions in cells and ion-protein interactions. The newly developed synchrotron radiation facilities were used to study the physical state of cellular potassium ions. It was found that the cellular K^+ ions are different from a free solution--they are bound to proteins. Theories of interpreting X-ray absorption spectra were developed. The newly developed technique of extended X-ray absorption fine structure was used to study K^+, Na^+ and Ca^{++} bindings to enzymes.- Reports 7-12.

3. Invention of time-resolved X-ray absorption spectrometer and its applications to study the protein dynamics and dynamics of ion movements in ion channels. → over

The development of intense synchrotron radiation made the study of structural dynamics possible by using time-resolved EXAFS. We designed and constructed a spectrometer for this purpose (Navy Case No. 67,047, US Patent No. 4,612,660). The technique was applied to study the sequence of heme structure changes in a photolyzed carboxymyoglobin (MbCO). We found

that the first step of the photodissociation is the movement of CO away from iron while the 5-coordinate heme structure almost remains unchanged. This is an extremely important finding, as the exact structure of the first intermediate state of photolyzed MbCO has been in controversy for a long time. The next application was to study the ion movements in ion channels - Reports 13-18.

4. Development of a technique for preparing a bulk phase of uniformly oriented ion channels in multilayers of lipids so that ion channels under electric field can be studied with spectroscopies and small-angle scatterings.)- Report 19.

→ Also included in this report is an index of all technical reports generated from the research

INDEX OF ALL TECHNICAL REPORTS

1. Status Report "Cellular Water Structure" 12 April 1976.

2. Technical Report "First-Order Approximation for the Time-dependent Ising Model" 9 February 1976.

3. Technical Report "Asymmetrical Ising Model" 9 February 1976.

4. Annual Report "Role of Cell Water in Regulation and Restoration of Cell Functions" 23 July 1976.

5. Annual Report "Interaction of Cellular Ions with Biological Molecules - Statistical Mechanics and Extended X-ray Absorption Fine Structures" 18 July 1977.

6. Status Report "Interaction of Cellular Ions with Biological Molecules" 30 September 1977.

7. Annual Report "Interaction of Cellular Ions with Biological Molecules by EXAFS" 10 July 1978.

8. Annual Report "Interactions of Cellular Ions with Biological Molecules by EXAFS 30 May 1979.

9. Status Report "Studying the State of Cellular Metal Ions by the Extended X-ray Absorption Fine Structures" 1 June 1979.

10. Interim Report "The Use of Synchrotron Radiation for the Study of Cellular Metal Ions" 16 May 1980.

ltrs. on file

The title for this report is correct.
Per Dr. Jeannine A. Majde, ONR/Code 1141CB

11. Annual Report "Interactions of Cellular Ions with Biological Molecules--Statistical Mechanics and EXAFS" 13 June 1980.

12. Annual Report "Study of Protein Dybamics by Time Resolved X-ray Absorption Spectroscopy" 11 May 1981.

13. Status Report "Study of Protein Dynamics by Time-Resolved X-ray Absorption Spectroscopy" 6 April 1982.

14. Annual Report "Study of Protein Dynamics by Time-Resolved X-ray Absorption Spectroscopy" 30 August 1982.

15. Progress Report "Study of Protein Dynamics by Time-Resolved X-ray Absorption Spectroscopy" 3 May 1983.

16. Annual Report "Structural Analysis of Calcium Binding Proteins by Time-Resolved X-ray Absorption Spectroscopy" 30 May 1987.

17. Annual Report "Study of Ion Bindings and Movements in Gramicidin Channels" 26 April 1985.

18. Annual Report Abstract "Structural Analysis of Ion Binding Proteins by Time-Resolved X-ray Absorption Spectroscopy 19 September 1985.

19. Annual Progress Report "Study of Ion Bindings and Movements in Gramicidin Channels" 16 September 1986.

INDEX OF ALL PUBLICATIONS

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